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LONG DATABASE REPORT ECOINFORMATICS

DUMIRA – a management related vegetation plot database of Dutch military ranges

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Abstract

In this paper we describe the historical background and contents of the DUMIRA vegetation plot database (GIVD-code EU-NL-003). It contains 13,046 relevés, collected between 1995 and 2018 at military ranges in the Netherlands, and it is updated regularly with new data. Historical circumstances led to the placement of military ranges at the most nutrient poor, dry, sandy soils, and as a result, the database is built up mainly by plots of *Calluno-Ulicetea* and *Nardetea* heathlands, *Koelerio-Corynephoretea* grasslands, and *Quercetea robori-petraeae* woodlands. These classes account for more than 50% of the database. Coastal communities (*e.g.* from the *Juncetea maritimae* and the *Therosalicornietea*) and scrubs (*e.g.* the *Lonicero-Rubetea plicati* and *Salicetea arenariae*) are other important sources. Notably, throughout the database, *Rubus* species are identified to species level. Although the DUMIRA database was initially used for management related vegetation mapping projects, the data gave rise to several more scientific studies and papers.

Taxonomic reference: Van der Meijden (2005) for vascular plants; Van de Beek et al. (2014) for *Rubus*; Kleukers et al. (2004) for *Orthoptera*.

Syntaxonomic reference: Mucina et al. (2016).

Abbreviations: DUMIRA = Vegetation plot database of Dutch Military Ranges; GIVD = Global Index of Vegetation-plot Databases; MoD = Ministry of Defence.

Keywords

Coastal vegetation, database, DUMIRA, grassland, heathland, management, military ranges, Netherlands, relevé, *Rubus*, scrub, TURBOVEG

Introduction

Vegetation research has a long tradition in the Netherlands, as was described in the long database report of The Dutch National Vegetation Database (Schaminée et al. 2012). As is clear from the overview in the Global Index of Vegetation-plot Databases (GIVD: www.givd.info/info_organisation.xhtml), with 600,000 plot records in this database, the Netherlands is the most extensively sampled country in Europe. From the beginning of the vegetation survey in this country, most attention was paid to natural and semi-natural systems, but until the 1990's, military training areas and air-fields were hardly sampled, mostly due to access restrictions. Sporadically, the vegetation was mapped for operational purposes (e.g. the estimation of the carrying capacity of the soil for military vehicles) or the evaluation of land use changes. These *ad hoc* mapping projects were replaced by a systematic and regular vegetation mapping project in 1996 after a two-year pilot period. This project has a long history though.

Most Dutch military areas were acquired between 1850 and 1920, when, mainly as a result of ongoing mechanisa-

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tion and the development of larger and heavier equipment, the need for larger areas for field exercises for the Dutch army increased. For obvious reasons, the most suitable areas were extensive and uncultivated common lands, consisting mainly of heath- and woodlands, and open dune areas, which coincidentally became available at that time (Gilissen 2013). As a consequence of the Inclosure Act ("Markenwet") of 1886, common lands were divided and sold, and the former Ministry of War claimed the cheapest areas, which evidently included the very poor, sandy soils, practically unsuitable for agriculture. In the twentieth century, with ongoing urbanization and the introduction of mineral fertilizer, the claim on land became more and more problematic, but over time the Dutch government was able to acquire tens of thousands of hectares of land as military training areas and air fields. After World War II, training exercises intensified, and increasingly heavier equipment was used. The introduction of so-called "free-for-all areas" - zones without any restriction for driving - had a very destructive influence on the vegetation.

In the nineteen-seventies, growing environmental awareness led to the sentiment that the army, with its intensified exercises, was partly responsible for the decline of species and ecosystems. This awareness eventually led to a more leading role of the national government in environmental and nature conservational policy. In 1994, a collaboration between the former Ministry of Agriculture, Nature and Food Quality and the Ministry of Defence (MoD) resulted in a project aiming at the survey of nature in military areas (Haveman 2012), focussing on breeding birds, butterflies and vegetation. From the start of the project, data collection served practical goals, *i.e.* management advice, decision making in spatial developments of the MoD areas, and the conservation of natural values, but not for answering of scientific questions as such. In a relatively short period of about 10 years, all larger military training areas, airbases and firing ranges were mapped, and from 2004 the first areas were revisited for the monitoring of the most important values. Nowadays a team of 8 ecologists is working on the monitoring of natural values on military areas, employed by the Central Government Real Estate Agency, part of the Ministry of the Interior and Kingdom Relations.

The basis for the vegetation monitoring is formed by the sequential mapping of the vegetation, in scale ranging mostly from 1:2,500 to 1:10,000. The mapped vegetation types are based on a set of local vegetation plot data (relevés). Practically from the beginning of the project, the relevé data is stored in a TURBOVEG-database (Hennekens and Schaminée 2001). Although the data from this database is used mainly in local typologies and for detailed descriptions of plant communities in military areas, the data is also used in several other large projects, of which the revision of the national classification (Schaminée et al. 2017) might be the most important one. The data and maps are also used for nature conservation policy, e.g. as a basis for the mapping of habitats in the framework of Natura 2000. More than 25 Dutch military ranges are designated as Natura-2000 sites, comprising more than half of the total area of the 25,000 ha of training areas, airfields and firing ranges.

GIVD Fact Sheet

GIVD Database ID: EU-NL-003			**Last update:** 2020-11-09
Dutch Military Ranges Vegetation Database (DUMIRA)		**Web address:**	
Database manager(s): Iris de Ronde (Iris.deRonde@wur.nl); Rense Haveman (Rense.Haveman@wur.nl)			
Owner: Central Government Real Estate Agency, Ministry of the Interior and Kingdom relations			
Scope: Vegetation plot database of military ranges in the Netherlands, mainly grasslands, heathlands and acidophilous forests. Also scrubs and salt marshes are well represented.			
Abstract:			
Availability: according to a specific agreement		**Online upload:** no	**Online search:** no
Database format(s): TURBOVEG		**Export format(s):** TURBOVEG	
Plot type(s): normal plots, time series		**Plot-size range:** 0.01 to 54909	
Non-overlapping plots: 13046	**Estimate of existing plots:** 13046	**Completeness:** 100%	**Status:** completed and continuing
Total no. of plot observations: 13587	**Number of sources (biblioreferences, data collectors):** 1		**Valid taxa:** 1995
Countries (%): NL: 100			
Formations: Forest: 12% = Semi-aquatic: 1%; Terrestrial: 11% // Non Forest: 92% = Aquatic: 1% (Haline water: 0%; Fresh water: 1%); Semi-aquatic: 8% (Haline water: 2%; Fresh water: 7%); Terrestrial: 83% (Non arctic-alpin: 83% [Natural: 20%; Semi-natural: 61%; Anthropogenic: 2%])			
Guilds: all vascular plants: 100%; bryophytes (terricolous or aquatic): 75%; lichens (terricolous or aquatic): 25%			
Environmental data (%): altitude: 0; slope aspect: 43; slope inclination: 23; microrelief: 0; surface cover other than plants (open soil, litter, bare rock etc.): 15; other soil attributes: 0; soil pH: 0; land use categories: 0; soil depth: 0			
Performance measure(s): presence/absence only: 0%; cover: 100%; number of individuals: 0%; measurements like diameter or height of trees: 0%; biomass: 0%; other: 0%			
Geographic localisation: GPS coordinates (precision 25 m or less): 90%; point coordinates less precise than GPS, up to 1 km: 7%; small grid (not coarser than 10 km): 1%; political units or only on a coarser scale (above 10 km): 3%			
Sampling periods: before 1920: 0%; 1920-1929: 0%; 1930-1939: 0%; 1940-1949: 0%; 1950-1959: 0%; 1960-1969: 0%; 1970-1979: 0%; 1980-1989: 0%; 1990-1999: 9%; 2000-2009: 60%; 2010-2019: 31%; unknown: 0%			
Information as of 2020-12-14 further details and future updates available from http://www.givd.info/ID/EU-NL-003			

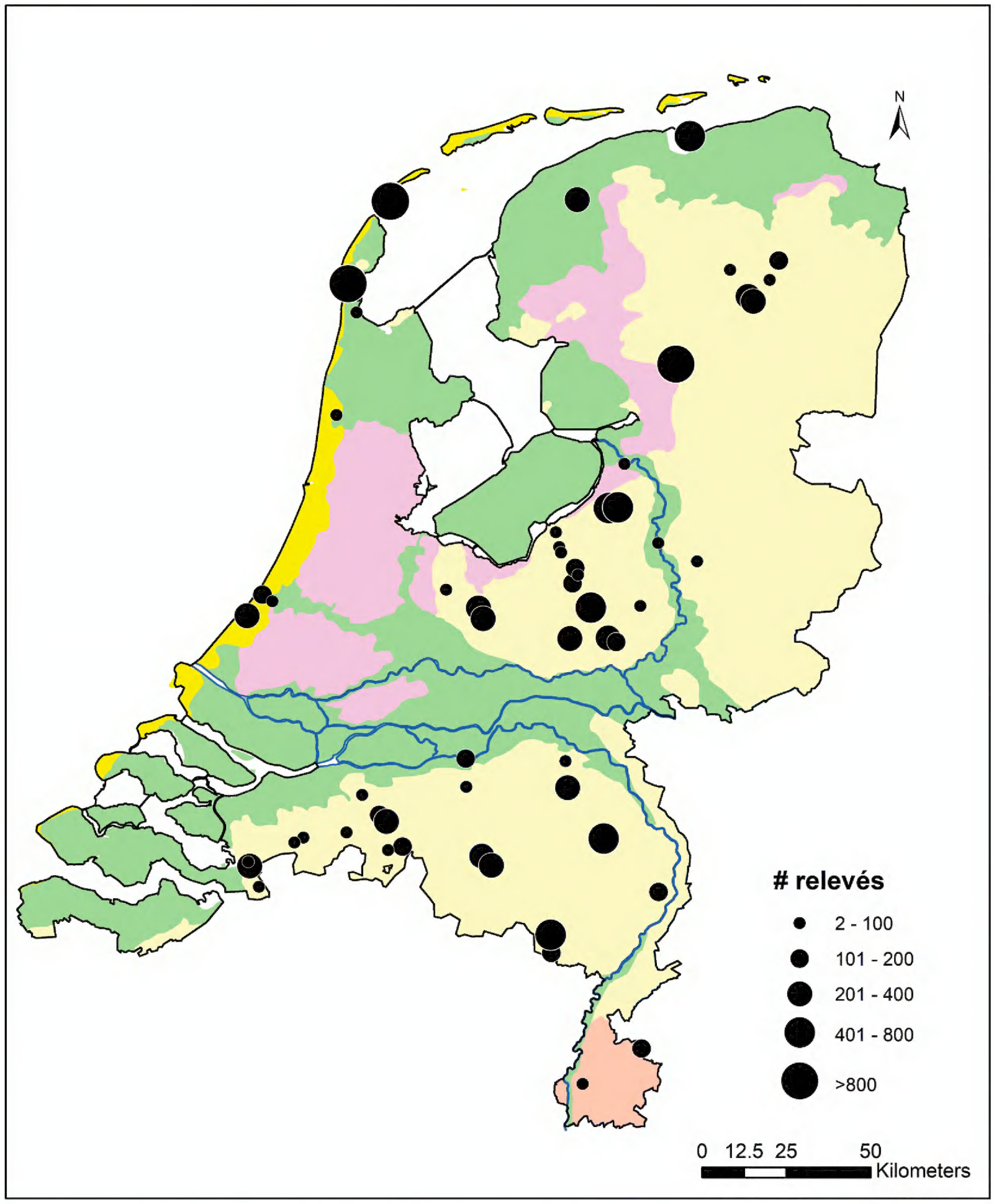

Figure 1. Distribution of relevés in the DUMIRA database made between 1995 and 2018. Dark yellow = coastal dunes; yellow = Pleistocene sands; green = marine and river clays; purple = fen peat; light orange = loess and limestone.

DUMIRA Database

As of November 2020, the vegetation plot database of Dutch Military Ranges (DUMIRA, registered in the GIVD as EU-NL-003) consists of 13,046 relevés, all from military areas in the Netherlands (Figure 1). Data collection started in 1995 and new data is added regularly, preferably annually. Over the years, data collection changed from pure analogue (on paper) to completely digital (tablets). Between 1995 and 2000, the relevés are lacking coordinates, or the coordinates are estimated at square kilometre level. From 2000 onwards, the coordinates were assessed with a GPS, and thus are much more accurate. From 2008, relevés are collected with electronic notebooks, using TURBOVEG CE, or, recently, TURBOVEG SD (Hennekens 2018). Almost two thirds of the number of relevés in the database date back to the time period 2000–2009, in which the focus was on the first inventory of the ranges. The actual number of relevés per year fluctuates considerably (Figure 2), which is the effect of the method used: relevés are collected in years prior to the actual mapping of the vegetation. Over the years, ten people contributed to the data collection; the authors of this paper contributed almost 75% of the total number of relevés. Less than 5% of the relevés are permanent plots, recorded in the 17-level Barkman, Doing and Segal scale (Barkman et al. 1964), which is basically a more detailed, modified Braun-Blanquet-scale. The large bulk of the relevés, however, is recorded

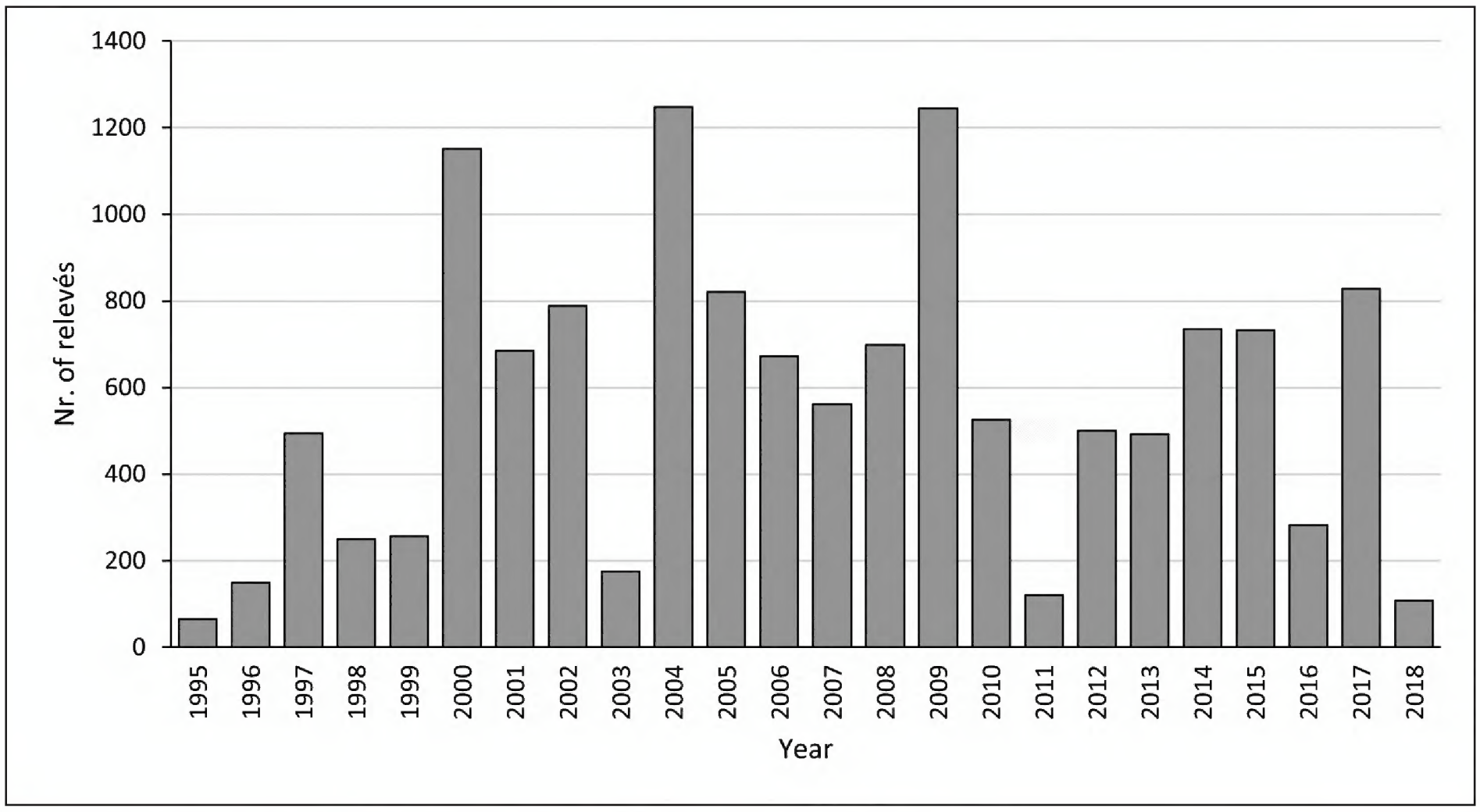

Figure 2. Number of relevés per year in the DUMIRA vegetation plot database.

in a slightly modified 9-scales form of the well-known Braun-Blanquet scale (Westhoff et al. 1995). About 18% of the relevés are indicated in the database as stratified random plots. The location of these relevés is not based on a field decision, but randomly chosen beforehand from the study area. Subsequently such sets of random plots are used to test the change in species composition in relatively homogeneous areas, for example in grasslands on airfields where reduction of the productivity is the main goal (De Ronde and Haveman 2008). Throughout, terrestrial mosses and lichens are included in the relevés. Especially in oligotrophic systems poor in vascular plants (like heathlands and inland dune communities), and in pioneer ecosystems (*e.g.* in pioneer dune slacks), cryptogams have proved to be important for the recognition and delimitation of communities. In the database, relevés of basal communities and transitional stages are well represented, since the relevés were intended to be used for mapping purposes from the beginning. Each relevé in the database is assigned to a phytosociological unit from the check list of Dutch plant communities (Schaminée et al. 2017) using the identification program ASSOCIA (van Tongeren et al. 2008).

As pointed out in the introduction, the military areas are not a reflection of the average Dutch landscape and its corresponding vegetation. Most training areas are found on dry, nutrient poor, sandy soils, which were not suitable for agriculture (see Figure 1 for the distribution of the relevés over the soil types). As a result of this unbalanced representation, relevés from peatlands, brooks, ponds, meadows, calcareous grasslands and mesic deciduous forests are either completely lacking, or seriously underrepresented in the DUMIRA database compared to the national database. In contrast, the DUMIRA database includes mainly data from dry grasslands on sandy soils (*Koelerio-Corynephoretea* Klika 1941) and more in detail silicicolous tussock grasslands of the *Corynephorion* Klika 1931 and meso-xerophytic closed grasslands of the *Sedo-Cerastion arvensis* Sissingh & Tideman 1960, dry inland heathlands (*Calluno-Genistion pilosae* P. Duvigneaud 1945), temperate Atlantic acidophilous oak forests of the *Quercion roboris* Malcuit 1929, pastures and meadows of the *Molinio-Arhenatheretea* Tx. 1937, and matgrass-swards of the *Violion caninae* Schwickerath 1944. Figure 3 shows the five classes with the highest numbers of relevés in the database, with all subordinate alliances represented with relevés in the database. As is clear from this figure, over two-thirds of the relevés of the *Koelerio-Corynephoretea*, *Calluno-Genistion*, *Quercion roboris* and *Violion caninae* can be assigned at alliance-level. Although the *Molinio-Arrhenatheretea* are well represented in the database at class level, over 90% of the relevés assigned to this class can only be classified at the order level or higher, which is a strong indication of the poor and fragmentary development of these grasslands at the Dutch military ranges, which is in correspondence with the initially nutrient poor environment.

Not included in the 5 largest classes in the database are the coastal communities of the *Therosalicornietea* Tx. 1958, *Juncetea maritimi* Br.-Bl. & Tx. 1952, *Honckenyo-Elymetea arenarii* Tx. 1966 (sub nomine *Ammophiletea* Br.-Bl et Tx. ex Westhoff et al. 1946), *Saginetea maritimae* Westhoff et al. 1962 and *Caricion viridulo-trinervis* Julve ex Hájek & Mucina 2015, but summarised these classes are represented with 1459 relevés. The majority of these relevés originate from two large training areas at the Wadden islands of Texel and Vlieland, located in highly dynamic young coastal landscapes. Another key characteristic of the DUMIRA database is the attention paid to shrub

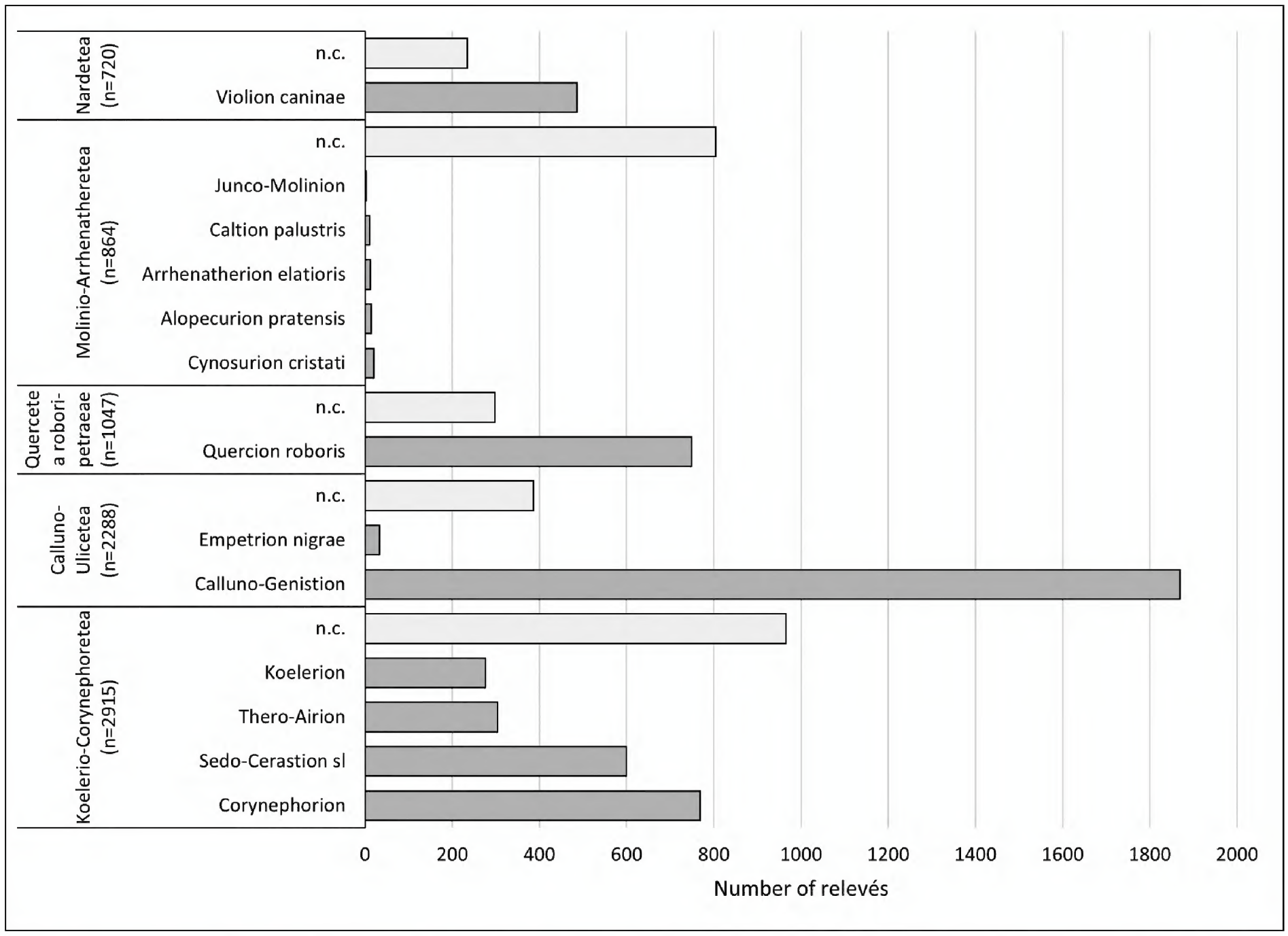

Figure 3. Number of relevés in the DUMIRA vegetation plot database for the five most sampled vegetation classes in the database per alliance. Dark grey bars represent the number of relevés assigned to the given alliance, light grey bars (n.c.= not classified) could not be assigned to one of the alliances.

communities of the *Salicetea arenariae* Weber 1999, *Lonicero-Rubetea plicati* Haveman et al. 1999, *Rhamno-Prunetea* Rivas Goday & Borja Carbonell ex Tüxen1952, and *Franguletea* Doing ex Westhoff 1969 (1294 relevés). Associated with this, but not limited to the scrub communities, *Rubus* apomicts are named at species level in the relevés; we think this is a unique feature of the DUMIRA database in comparison to most other vegetation databases. In the DUMIRA database, 1797 relevés contain 96 brambles species from *Rubus* subgen. *Rubus*; *Rubus plicatus* (n = 911) and *Rubus gratus* (n = 713) are the most frequently recorded species, again affirming the poor nutrient status of most soils in Dutch military areas.

Output

From 1995 onward, vegetation maps are made of more than 60 military areas, ranging from a few to several thousand hectares, and some of these areas have been mapped for the third time already. Most of the maps are published as internal reports, but they are also made available for external organisations (mostly the provincial administration) for the monitoring of the area and quality of Natura 2000 habitats, and the article 17 reporting to the EU. The DUMIRA database has further been the basis for many broad to very specialised studies, mostly published as internal reports, *e.g.* large overviews concerning the contribution of the MoD areas to the nature in the Netherlands, recommendations on the management of airfield grasslands, the habitat requirements of endangered species in Natura 2000 areas, and a landscape ecological analysis of the large military range at the Wadden Island of Texel.

Although the DUMIRA database has a very practical basis, with its main use in the daily mapping practise of military ranges, the data also gave rise to papers on a wide range of subjects, some of which we mention here. One category of published papers is dealing with rare species or species of special (nature conservation) interest, like *Mibora minima* (Haveman and de Ronde 2012). More often, the mapping of military ranges led to syntaxonomical discussions, sometimes urging the need for studies beyond the strict borders of the military areas. Two examples are the *Rubetum taxandriae* Haveman & De Ronde 2012 (class *Lonicero-Rubetea* Haveman et al. 2012), and the *Senecioni ovati-Rubetum iuvenis* Haveman et al. 2014 (alliance *Athyrio filicis-feminae-Rubion idaei* Haveman et al. 2014, class *Crataego-Prunetea* Tx. 1962, Haveman et al. 2014), two bramble scrub associations, which were recognised for the first time on military areas, but both

have a wider distribution in western Europe. Further investigations in the mountainous areas of Europe might reveal more associations belonging to the later mentioned alliance (Haveman et al. 2014). The vegetation mapping practice not only led to new insights in the classification of bramble scrubs though. In a recently published revision of the National Vegetation Classification (Schaminée et al. 2017), the treatment of several classes (*e.g.* the *Nardetea* Rivas Goday & Borja Carbonell 1966, *Calluno-Ulicetea* Br.-Bl. et Tx. ex Klika & Hadač 1944, *Lonicero-Rubetea plicati*, and the *Salicetea arenariae*) was based on the insights gained during the mapping of the vegetation on military ranges, and to a considerable extent on relevés from the DUMIRA database.

Occasionally, the data in the DUMIRA database is used to describe the habitat of rare animal species in the Netherlands. An example is given by the description of the species composition of the plant communities at the Oldebroekse Heide, a large heathland remnant harbouring the westernmost population of *Gampsocleis glabra* (*Orthoptera*) in Europe (Van der Berg et al. 2000).

Final remarks

The DUMIRA database is an active database which is complemented regularly with new relevés from military areas. As before, most relevés will be collected for mapping purposes, but more specific studies will probably be carried out. As is shown in the above, the database was built in a period of 25 years in a project aiming at subsequent vegetation mapping of the military ranges in the Netherlands. The first goal has never been the scientific study of the synsystematics of one or more biomes, formations or classes, but the database merely grew as a by-product of the mapping of the vegetation, in service of practical conservation questions. Comprising over 13,000 relevés, it has shown to be of important value however, even for more (descriptive) scientific questions. Although a rather recent branch on the phytosociological tree, large databases can contribute to our understanding of the vegetation, especially of large scale patterns (e.g. Wagner et al. 2017). But more than 80 years ago, the "Altmeister" of phytosociology, Reinhold Tüxen, in the preface of the dissertation of the Dutch forester and phytosociologist W.H. Diemont, appointed the value of vegetation mapping as an instrument to "sharpen the eye", as a result of which the fine details in the vegetation, below the association and subassociation level, are observed, and understood (Tüxen 1938). This remark still hasn't lost its value: for the understanding of the almost endless variation in the vegetation, and its relation to the landscape, vegetation mapping is difficult to replace. In the light of the still growing pressure on the landscape and its natural inhabitants, the value of vegetation mapping can hardly be overestimated. We hope and believe that in the future the DUMIRA database will serve both these two goals: first of all the understanding of small scale variation in the vegetation and its causes, as an instrument for the conservation of natural values, and, as a good second, also a more synthetic overview of the vegetation over larger, regional to continental, areas.

Author contributions

I.R. and R.H. conceived the idea and outline of the text, I.R. wrote the first concept. R.H. and I.R. edited several text versions and all authors checked and improved the final concept of the manuscript. All authors contributed to the database.

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